

REMARKS

Claims 38-45 are presently pending in this application. Claims 38 and 40 have been amended to clarify certain aspects of these claims. The status of the application in light of the Office Action dated 10 December 2004 is as follows:

(A) Claim 40 is subject to an objection on the grounds that it contains minor spelling errors.

(B) Claims 38 and 39 stand rejected under 35 U.S.C. § 103 over the combination of U.S. Patent No. 6,418,615 issued to Rokugawa et al. ("Rokugawa") and U.S. Patent No. 5,578,525 issued to Mizukoshi ("Mizukoshi").

(C) Claims 38-45 stand rejected under 35 U.S.C. § 103 over paragraphs 0002-0004 of the Background section of the present application ("Background Information") and Mizukoshi.

A. Response to the Objection of Claim 40

The Examiner objected to claim 40 on the grounds that "solder" and "the" were misspelled at line 6. Based on the scanned copy of the claims in the Image File Wrapper available on PAIR, the terms "solder" and "the" in line 6 of claim 40 are spelled properly. The applicant accordingly requests withdrawal of this objection.

B. Response to Section 103 Rejection—Rokugawa and Mizukoshi

Claims 38 and 39 were rejected under 35 U.S.C. Section 103 over the combination of Rokugawa and Mizukoshi. The applicant thanks the Examiner for including the relevant figures of these references and a detailed explanation of the Examiner's position. For the reasons explained below, amended claim 38 is patentable over this combination of references.

Claim 38 is directed toward a packaged microelectronic device that is ready to be attached to a printed circuit board. Several embodiments of packaged microelectronic devices in accordance with claim 38 comprise a microelectronic die having an integrated circuit and a plurality of bond-pads coupled to the integrated

circuit. The packaged microelectronic devices further include an interposer substrate having a first side coupled to the die, a second side opposite the first side, a plurality of ball-pads arranged on the second side to be coupled to a printed circuit board, interconnects electrically coupled to the bond-pads on the die and the ball-pads, and a solder-mask on the second side having openings over the ball-pads. The packaged microelectronic devices further include (a) a plurality of solder-balls arranged so that each solder-ball is in an opening through the solder-mask and in contact with a corresponding ball-pad, and (b) a dielectric compound in the openings through the solder-mask. The dielectric compound surrounds a portion of the perimeter of each of the ball-pads and the solder-balls.

Several embodiments of microelectronic devices in accordance with claim 38 are well suited for electrically connecting the solder-balls on the second side of the interposer substrate to a printed circuit board. One aspect of these microelectronic devices is that the dielectric compound in the openings of the solder-mask electrically insulates the ball-pads and the solder-balls from any exposed portions of adjacent trace lines on the interposer substrate. As a result, when such packaged microelectronic devices are attached to a printed circuit board and the solder-balls are reflowed, the dielectric compound prevents the molten solder from contacting exposed portions of adjacent trace lines. The dielectric compound accordingly prevents electrical shorts on the interposer substrate.

The applied art is directed toward flip-chip mounting of a microelectronic die to an interposer substrate. Rokugawa, more specifically, is directed toward a method of making a multilayered substrate to which a semiconductor device is attached. Figure 1 of Rokugawa discloses a substrate 14 having a first side including a plurality of pads 20a to which electrode terminals 18 of a semiconductor element 16 are attached. The multilayered substrate 14 disclosed in Rokugawa also has a second side with pads 24 to which solder-balls 22 are attached to provide an external connection for attachment to a printed circuit board. The solder balls 22 on the second side of the substrate 14 completely cover the pads 24.

Mizukoshi appears to be directed toward a semiconductor device for use in stacked die arrangements. Referring to Figure 4 of Mizukoshi, this reference discloses a semiconductor chip 21, a package substrate 22 having a first surface 25 to which the semiconductor chip 21 is attached, and a second surface 22a with ball-pads 28 to which solder balls 29 are attached. The semiconductor chip 21 includes electrode pads 24, and the package substrate 22 includes electrodes 26 formed on the first surface 25. The electrodes 24 of the semiconductor chip 21 are attached to the electrodes 26 on the package substrate 22 by solder-bumps 27. The semiconductor chip 21 is also encapsulated by a resin 32.

Claim 38 is patentable over the combination of Rokugawa and Mizukoshi because these references fail to teach the combination of elements of claim 38. The microelectronic devices of claim 38 are directed toward having a dielectric compound surrounding at least a portion of the solder-balls on the external side of the interposer substrate to which a printed circuit board is to be attached. This aspect of claim 38 is set forth by the following combination of elements: an interposer substrate having a first side to which the die is coupled; a plurality of ball-pads arranged on the second side to be coupled to a printed circuit board; a solder-mask on the second side having openings over the ball-pads; solder-balls arranged in the openings of the solder-mask in contact with corresponding ball-pads; and a dielectric compound in the openings of the solder-mask that surrounds at least a portion of the perimeter of each of the ball-pads and the solder-balls. In contrast to claim 38, the proposed combination of Rokugawa Mizukoshi as set forth in the pending Office Action would result in a device in which the resin 32 taught in Mizukoshi would fill the space between Rokugawa's semiconductor element 16 and interposer substrate 14 shown in Figure 1. The proposed combination of Rokugawa and Mizukoshi accordingly does not disclose or suggest the claimed structure of having a dielectric compound surrounding solder-balls in openings of a solder-mask on a side of the interposer substrate opposite the side to which the microelectronic die is attached.

Claim 38 is accordingly patentable over the combination of Rokugawa and Mizukoshi. Claim 39 is patentable over this combination of references as depending from allowable claim 38, and also because Mizukoshi does not disclose a dielectric flux.

C. Response to Section 103 Rejection—Background Information and Mizukoshi

Claims 38-45 were rejected over the Background Information in combination with Mizukoshi. In rejecting these claims over the Background Information, the Examiner states that the Background Information discloses a microelectronic die having a plurality of bond-pads, an interposer substrate having a plurality of ball-pads electrically coupled to the bond-pads on the die, a solder-mask having openings over the ball-pads, and a plurality of solder-balls arranged so that each solder-ball is in an opening in the solder-mask in contact with a corresponding ball-pad. The Examiner admits that the Background Information does not disclose a dielectric compound surrounding a perimeter portion of each of the ball-pads and the solder-balls. To overcome this shortcoming of the Background Information, the Examiner cites Mizukoshi for the proposition that it would have been obvious to use the dielectric compound disclosed in Mizukoshi over the "IC and the whole top surface of the interposer" disclosed in the Background Information.

The rejection of claims 38-45 is without merit because the characterization of the Background Information set forth in the Office Action is incorrect. First, the Background Information discloses a microelectronic die attached to an interposer substrate such that bond-pads on the die are connected to traces on the interposer substrate, and the traces are connected to ball-pads. The ball-pads are not on the upper side of the substrate to which the die is attached as characterized in the "Office Action," but rather the ball-pads are in a "ball-grid" array configured to be attached to a separate printed circuit board. The Background Information further discloses that discrete volumes of a solder paste are deposited onto the printed circuit board contacts, and then the solder-balls are pressed into the solder-paste. As such, the Background Information teaches that the openings in the solder-mask are filled with the conductive solder paste. The

Examiner cannot disregard this teaching of the Background Information, but rather must take the Background Information as a whole.

Claims 38-45 are patentable over the combination of the Background Information and Mizukoshi because this combination of references fails to set forth several features of independent claims 38 and 40. For example, even if the resin of Mizukoshi was disposed "over the whole top surface of the interposer" disclosed in the Background Information as proposed in the Office Action, then the resin of Mizukoshi still would fail to be in the openings of the solder-mask on the second side of the interposer substrate opposite the side to which the die is attached. Moreover, if the resin of Mizukoshi is applied to the external side of the interposer substrate set forth in the Background Information, the preexisting solder paste in the openings of the solder-mask would prevent the resin of Mizukoshi from surrounding at least a portion of the perimeter of each of the ball-pads and the solder-balls. As a result, the ball-pads and solder-balls would not be electrically insulated from exposed portions of adjacent trace lines in the proposed combination of the Background Information and Mizukoshi. Therefore, independent claims 38 and 40 are each patentable over the combination of the Background Information and Mizukoshi.

Claim 39 is patentable as depending from claim 38, and also because claim 39 is directed toward a dielectric compound that is a dielectric flux. Claim 41 is similarly patentable as depending from independent claim 40 and because it is directed toward a dielectric compound comprising a dielectric flux. The Examiner asserts that the resin in Mizukoshi is a dielectric flux because Mizukoshi teaches that the compound is a "fluid" resin. A flux, however, is a material that aids, induces or otherwise actively participates in the fusing or flowing of different parts during a reflow process. Fluxes typically become very flowable and at least partially burn away during reflow processes. As such, it is unlikely that the resin in Mizukoshi is a dielectric flux because if a dielectric flux was used to encapsulate the semiconductor chip in Mizukoshi, such a flux may burn away and destroy the encapsulation of the semiconductor chip during reflow processes. Therefore, claims 39 and 40 are further patentable on their own merits over

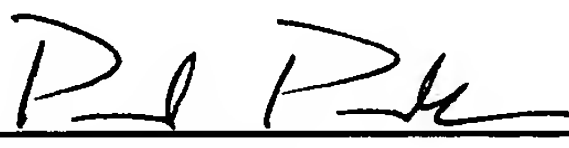
the combination of either (a) Rokugawa and Mizukoshi or (b) the Background Information and Mizukoshi.

Claims 41-45 are patentable over the combination of the Background Information and Mizukoshi as depending from independent claim 40 and because of the additional features set forth in these claims. For example, claim 42 further includes that the device comprises a circuit board having a contact coupled to the solder-ball. Therefore, claims 38-45 are patentable over the combination of the Background Information and Mizukoshi.

In view of the foregoing, the pending claims comply with 35 U.S.C. § 112 and are patentable over the applied art. The applicant accordingly respectfully requests reconsideration of the application and a mailing of a Notice of Allowance. If the Examiner has any questions or believes a telephone conference would expedite prosecution of this application, the Examiner is encouraged to call the undersigned at (206) 359-3258.

Respectfully submitted,
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